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CONTINUOUS OPERATIONS SOP FOR BIFV UNITS

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Based upon the analysis of the Threat and the emerging role of the Bradley in combined arms operations, it is apparent that there is a clear need for increased Bradley Infantry Fighting Vehicle (BIFV) unit awareness of the combat-relevant aspects of continuous operations. This need must be met by providing small unit leaders with appropriate tools for preparing to survive and fight under conditions of prolonged operations. One of these tools is a Continuous Operations (CONOPS) Annex To Company Tactical Standing Operating Procedure. This SOP provides guidance suitable for establishing a routine work/rest schedule that

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20. Abstract (Continued)

units can use immediately to improve sleep discipline. Placing guidelines for the conduct of continuous operations in the hands of leaders at company/platoon/squad levels will increase awareness of the issue and provide a tool for evaluating unit implementation of continuous operations procedures during unit ARTEPS.

FOREWORD

Since 1975 the Army Research Institute has contributed to the U. S. Army program to develop Bradley Infantry (M2) and Cavalry (M3) Fighting Vehicles, including human factors evaluation of prototype vehicles and task analyses of crew tasks to identify special aptitude requirememts. Further task analysis resulted in preparation of a set of Procedures Guides for Bradley Commanders, Gunners, and Drivers, identification of leader tactical training device requirements, and recommendations for a Bradley Leader Tactical Trainer.

As Bradley vehicles began to be introduced to combat units, the need to evaluate tactical doctrine, operational effectiveness, and training issues in a systems context became apparent. At the request of the Deputy Chief of Staff for Training, U.S. Army Training and Doctrine Command (TRADOC) a research program was formalized among the Training Technology Agency, TRADOC, the U. S. Army Infantry School, and the Army Research Institute, to define emerging operational and training problems and to undertake research to address the most critical issues affecting combat effectiveness. Because Bradley vehicles incorporate advanced weapons systems and sights to be used under darkness and reduced visibility, special emphasis was placed on research which focused on operations under these conditions.

The first year of the project resulted in definition of critical research issues and identified gunnery, tactical operations, equipment, and training as topical areas for subsequent research and development. The problem identification and supporting analyses are presented in a separate report.

The results of the second year of research are documented in a series of publications, of which the present report is one. The emphasis of the second year effort was on making products available to Bradley users as they were developed. These analyses, training materials, job performance aids, improved procedures, and equipment prototypes have thereby served immediately to increase combat effectiveness. Further interactions between the project scientists and the user community have resulted in additional improvements and refinements. As a result of this approach the project has been unusually responsive to both the U. S. Army Infantry School and Bradley units worldwide.

CONTINUOUS OPERATIONS SOP FOR BIFV UNITS

CONTENTS

PROBLEM DEFINITION

The lessons learned from past conflicts include periods of combat which have become known by the term "continuous operations," during which US Army units have performed combat tasks round-the-clock, without respite for periods of weeks or months. Continuous operations encompass, of course, not only active contact with the enemy, but also planning/preparation for engagements and reorganization after operations.

Concepts for Army 21 support the conclusion that periods of continuous operations will be highly probable in future conflicts. For example, Soviet doctrine indicates that they will attempt to use shock and constant pressure as offensive weapons. Also, early successes in the initial stages of future conflicts will be even more critical for the eventual outcome than in the past; therefore, US units must be prepared, at the outset, to react to prolonged enemy offensives and to capitalize upon its own successes.

The military lessons learned point out that the task performance of even the best-trained individuals becomes degraded in the latter stages of continuous operations. Continuous operations are characterized by conditions of task overload, physically debilitating environments, fatigue/sleep loss, and exposure to life-threatening situations. These major contributing causes of performance degradation have a combined effect at any given time and are progressive in intensity over prolonged exposure.

There is an extensive body of basic research that has investigated the aspects of tasks that are most susceptible to the degrading effects of continuous operations. In general, effects occur earliest for tasks requiring perceptual speed and visual acuity, fine motor skills, memory, reasoning/decision making, vigilance, or communication/interaction with team members. The Army Research Institute has performed extensive work in this area that resulted in the publication of militarily-oriented guidelines for conteracting the effects of continuous operations on the most susceptible combat tasks. (See Appendix B.)

During on-site visits to BIFV units in USAEUR and CONUS, research team members observed ARTEPs spanning a nine-day period. The nature of the exercises was such that many of the characteristics of continuous operations were realistically created. Observers were prepared to take advantage of this opportunity and the consensus conclusion was that there is a general lack of awareness, within BIFV units, of the lessons learned pertaining to continuous operations. Observers experienced first-hand the effects of confinement within the BIFV troop compartment for periods up to eight hours. Over time, the troop compartment itself can become a debilitating environment for an individual, through the accumulated effects of crowding, vehicle motion, fumes, and psychological reactions akin to claustrophobia stemming from combat anxiety and uncertainty about conditions existing outside the vehicle at any given time. Measures to counter these effects were non-existent or haphazard from one vehicle to the next.

Additional information was developed through observation of the behavior of leaders over the course of the exercise and leader replies to queries related to continuous operations issues. Both leader behavior and leader opinions

indicated the widespread existence of counterproductive attitudes about leadership requirements during continuous operations, and/or gaps in knowledge of measures for countering debilitating effects upon their troops and themselves.

For example, junior leaders became progressively exhausted in the latter stages of exercises as a result of failure to sleep when the tactical situation would have permitted this. A platoon sergeant was observed to act as the vehicle commander during the entire four-day exercise with only four hours of sleep, despite the fact that he had a qualified commander in his vehicle. In another example, a platoon leader fell asleep from exhaustion while his unit was occupying a defensive position. He did not awaken until the enemy was on both flanks of and behind his position. His desparate reaction was to lead his unit out of the area at speeds which could have produced accidents and endangered the entire command. The ARTEP controllers failed to properly declare the platoon a casualty and the opportunity to relate the incident to the issue of sound sleep procedures for leaders was overlooked in the ARTEP evaluation.

Further investigation by the observers indicated that senior commanders wanted junior leaders instantly available and ready for rapid reaction. Subordinate leaders' perception of this attitude caused them to ignore normal sleep procedures and, as their exhaustion increased, so did errors of ommision and commission. Fatigue accounted for failure to dismount personnel in appropriate situations, to provide adequate warnings on the tactical situation to subordinate leaders, and to capitalize on tactical situations.

In short, it appeared to be the belief among leaders at all levels that they should "tough it out" until the end of the exercise, and that implementing measures designed to counteract the effects of continuous operations, for themselves or their troops, would be considered substandard leadership behavior by their immediate superior.

The Army maxim of training the way it will have to fight applies to the issue of continuous operations. The observed lack of readiness on the part of BIFV units for fighting under these conditions qualifies this as an area of prime concern; it was selected by the ARI/Litton research team fo further development and evaluation during the second year of the project.

APPROACH

The research team re-examined the literature having relevance to continuous operations conducted by BIFV units. Current training practices in resident BIFV-courses and in the units were analyzed to isolate instructional content and pratical exercises which would prepare personnel for continuous operations. In the latter case, the void that currently exists is epitomized by the fact that BIFV resident and unit training does not emphasize the need for establishing and implementing a unit SOP (Standing Operating Procedure) for continuous operations.

Standing Operating Procedures prescribe routines or techniques for the accomplishment of duties that units or individuals will perform in

essentially the same way a preponderance of the time. Within tactical units there is a document referred to as the Tactical SOP. This document is directive in nature and causes all components or sub-elements of a unit to perform combat and combat support tasks in a uniform, specific way. Examples of routines incorporated into a BIFV company tactical SOP include: dismount drills; immediate action drills; reporting; mounted combat formations; vehicle combat loading; ammunition stockage levels; resupply for Class I, III and V materials; passive and active air defense measures; and similar combat related activities.

Continuous Operations Standing Operating Procedures will be found as annexes to many battalion and brigade level SOPs, but are not existant at company level. Even when incorporated in battalion tactical SOPs, continuous operations procedures tend to be ignored in the field environment. Commanders and staff personnel alike extend themselves for protracted periods with little or no rest -- resting on a scheduled basis is unusual.

Human maintenance needs which are critical to unit combat effectiveness and performance of combat oriented tasks receive little or no emphasis. The requirement to insure that personnel, and in particular, small unit leaders, obtain sufficient sleep to remain at a high level of efficiency over the course of prolonged combat operations is essential. Yet, little or nothing has been done to establish a routine that will cause key personnel to sleep while still insuring that their duties are performed by alternate personnel.

An effective work/rest schedule would require flexibility in scheduling. Leaders must understand the principles and human factor needs behind the continuous operations SOP. In addition, they must be able to adapt the routine as necessary in fast developing combat operations. Further, implementation of the work/rest program must be supported by leader recognition of the need for cross training of personnel so that critical skills are not lost during sleep/rest periods.

At present, neither Army Training and Evaluation Programs (ARTEPs) nor ARTEP Mission Training Plans (AMTPs) isolate continuous operations for special attention. Neither series of documents causes controllers/ observers to check upon proper rest cycles as a leadership task for evaluation. Without a scoring procedure and/or a system which adds or subtracts points for (non)compliance, commanders will ignore this area or give it less attention than is required. As was pointed out earlier, going without rest for the period of a short field training exercise is not going to have the same impact as lack of rest for an equivalent period in a combat environment. However, if the axiom "we train as we fight" has meaning, then units are not now prepared to perform for extended periods in combat.

Modification of current ARTEPs and AMTPs to include specific evaluations of how well leaders implement a continuous operations SOP would be a step forward in increasing unit readiness to fight for prolonged periods. It would be important for the ARTEP to provide scoring of CONOPs (Continuous Operations) at every tactical phase, and in every 24 hour period. In this way, commanders at squad through battalion level would see CONOPs as a scored criterion for successful exercise completion.

It was determined by the research team that the creation of a Continuous Operations SOP would have an immediate impact upon both attitudes and behavior. That is, it would both signal command emphasis on the employment of countermeasures and provide guidance on unit-wide implementation of techniques to off-set degradation of performance under conditions of continuous operations.

The ARI/Litton BIFV research team could develop a unit-ready SOP in minimal time because the composition of the team provides the requisite knowledge of the literature, behavioral science expertise, prior combat experience, and BIFV-specific expertise. To insure immediate and effective use by platoon and squad leaders, the SOP was prepared in standard military format with this audience in mind. The principles of selectivity and condensation were applied to the voluminous information available for inclusion in an SOP, to control its length and emphasize the most critical action items in terms immediately understandable by junior leaders.

Several iterations were prepared and staffed with BIFV SMFs. The version presented in the following subsection represents a trade-off between competing requirements; the need for brevity and simplicity was balanced against comprehensive coverage of the most essential measures for maintaining individual and unit effectiveness during continuous operations.

The Continuous Operations SOP

The text of the proposed ARI/Litton CONOPS SOP is presented in Appendix A. A brief description is given here. A four paragraph format for a Continuous Operations annex to the company Tactical Standing Operating Procedure was employed. Paragraphs devoted to "Purpose" and "General" introduce the requirement for leaders to recognize the effects of continuous operations upon personnel in their command and the requirement for insuring that sleep discipline is enforced. The third paragraph presents a Detailed Plan for the continuous operations SOP and introduces a company-wide rest schedule. The schedule divides the day into four six-hour periods and assigns personnel in each duty position to a sleep/rest period. The two periods spanning the normal darkness hours of 2000-0800 are the primary periods with the daylight hours available as an alternative schedule if required. The assignments are based upon an underlying logic that recognizes the typical requirements of company tactical operations and insures that an alternate is available to perform the most critical functions when the individual with primary responsibility is resting as scheduled. For example, the company commander is assigned to rest during the first portion of the night while the executive officer remains awake. Individuals normally rest best during the hours of 0200-0800, but it is appropriate for the company commander to be alert during this period since it generally presents more complex tactical demands than the early part of the night (2000-0200 hours). As a further example, assignments across the three platoons are designed so that not all leaders are asleep at the same time and platoon leaders and platoon sergeants alternate sleep/rest periods. As noted in the text of the SOP, leaders may have to adjust either the sleep

periods or personnel assignments as the tactical situation dictates, but the proposed schedule offers a logical approach for most situations and a framework for appropriate adjustments.

CONCLUSIONS

There is a clear requirement for increased BIFV unit awareness of the combat-relevant aspects of continuous operations. Appropriate tools for preparing to survive and fight under these conditions must be provided to units. The SOP at Appendix A provides guidance suitable for establishing a routine work/rest schedule that units can use immediately to improve sleep discipline.

This section has described developmental work that will have an immediate impact upon units. Placing guidelines for the conduct of continuous operations in the hands of leaders at company/platoon/squad levels will increase awareness of the issue and provide a tool for immediate use.

RECOMMENDATIONS

It is recommended that:

- The ARI/Litton Continuous Operations SOP be disseminated to unit commanders and trainers;
- Follow-up work be planned to accumulate field comments and experiences with implementation of the SOP.
- BIFV ARTEPs be modified to permit evaluation of implementation of sound continuous operations procedures and penalization of individuals and units that fail to conform.

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APPENDIX A

THE PROPOSED CONOPS STANDING OPERATING PROCEDURE

ANNEX __, Continuous Operations (CONOPS)
TO TACTICAL STANDING OPERATING PROCEDURE. __ January 1986
COMPANY __/ __-___INFANTRY/ __ BRIGADE

1. PURPOSE. The purpose of this Annex is to prescribe procedures for the conduct of Continuous Operations (CONOPS) within this company.

2. GENERAL. Soldiers and leaders cannot work for extended periods without adequate rest. Continuous operations demand units be able to function indefinitely. The only way these two requirements can be met without serious conflict is through the use of both common sense and a schedule for rest which permits a portion of the squad, platoon and company to sleep while the remainder of the unit remains in a high state of alertness. In addition, it is necessary for every man to be cross-trained in at least one other duty position so critical skills are not lost during sleep periods.

3. DETAILED PLAN. Squad and platoon leaders have two special responsibilities for continuous operations. First, they must observe their personnel closely for signs of excessive fatigue or exhaustion, and order rest to avoid combat losses. Second, they must crosstrain their soldiers so combat skill loss is minimized during any rest cycle. For example, drivers and gunners require special training. At least two or more soldiers from the dismount team must be able to perform driver and gunner duties when those personnel are resting (gunners, especially, are in need of frequent replacement at night, since skill loss is significant after about two hours of thermal scanning).

a. Generally, leaders will be replaced by assistant leaders during rest periods. For example, the company commander will be replaced by the company executive officer; the platoon leader by the platoon sergeant; and, the squad leader by the assistant squad leader.

b. Leaders MUST make every effort to rest during the period they are scheduled. If this is not possible, the rest must be taken at the earliest opportunity. Leaders will not try to "tough it out." Such actions are forbidden. Sleep loss DOES cost lives through loss of judgement and alertness!

c. Although scheduled rest is best, it may not be practical in fast-developing situations or periods of extended direct combat. The leader is responsible for seeing required rest is taken. AVOID THE SITUATION WHERE AN ENTIRE UNIT GOES TO SLEEP BECAUSE THE LEADER WAS NOT WISE ENOUGH TO SCHEDULE REST.

d. The attached schedule provides four periods of six hours each during each 24 hour day. The best of all solutions would be to have one fourth of the squad, platoon and company at rest all of the time. As discussed at paragraph 3 c, above, this is not logical when unit is moving and/or unit is engaged in combat with the enemy. However, common sense dictates that when the unit is moving some of the dismount element can be asleep in the troop

compartment unless unit is in contact. The same philosophy applies when in the defense. Unless in contact with the enemy, a portion of the squad or platoon frequently can be at rest while the remainder of the unit completes positions, maintains security and surveillance, and performs other essential duties. Even when in contact, it is necessary for some portion of the unit to be resting or the unit will all become exhausted and combat ineffective at about the same time.

e. The BFV unit is unique in that small units are isolated from each other. Leaders are required to make independent decisions more than in any other infantry-type unit. Rest is one of the more important obligations of the small unit leader.

f. Every leader in this company is to see that the personnel under his command get a minimum of four hours sleep in every 24 hours. To the degree possible the goal should be to get six hours of sleep. The leader MUST receive a minimum of four hours sleep daily.

4. IMPLEMENTATION. The attached schedule for work and rest is to be used for guidance by all personnel.

_____
Commanding

Appendix 1, Work/Rest Schedule, to ANNEX __, CONOPS, to Tactical Standing Operating Procedure, Company __/ __ -___Infantry/ __ Brigade

POSITION	ALT.PSN.	CO.HQ.	1stPLT	2dPLT	3dPLT	COMMENT
CO		A				
XO		B				
1SG		C				
M/GNR		B				
CLK		A				
COMMO		B				
SUP.		C				
MTR		C				
PLT HQ						
PL/BC			A (C)	B (D)	A (C)	
M/GNR	(BC)		B (D)	A (C)	B (D)	
ASL	(GNR)		B (D)	A (C)	B (D)	FM 3D SQ
RATELO	(DR)		B (D)	A (C)	B (D)	
DRIV	(GNR)		A (C)	B (D)	A (C)	
FO			B (D)	A (C)	B (D)	
MED			A (C)	B (D)	A (C)	
1ST SQD						
SL/BC			B (D)	A (C)	B (D)	
ASL	(SL)		A (C)	B (D)	A (C)	
GNR			B (D)	A (C)	B (D)	
DR			B (D)	A (C)	B (D)	
AR	(DR)		A (C)	B (D)	A (C)	
AR	(GNR)		B (D)	A (C)	B (D)	
GREN	(GNR)		A (C)	B (D)	A (C)	
AAS	(DR)		A (C)	B (D)	A)C)	
R/S			A (C)	B (D)	A (C)	
2ND SQD						
SL/BC			A (C)	B (D)	A (C)	
ASL	(SL)		B (D)	A (C)	B (D)	
GNR			A (C)	B (D)	A (C)	
DR			B (D)	A (C)	B (D)	
AR	(DR)		A (C)	B (D)	A (C)	
AR	(GNR)		B (D)	A (C)	B (D)	
GREN	(GNR)		A (C)	B (D)	A (C)	
AAS	(DR)		A (C)	B (D)	A (C)	
R/S			B (D)	A (C)	B (D)	
3D SQD						
PSG/BC			B (D)	A (C)	B (D)	
SL	(BC)		A (C)	B (D)	A (C)	
GNR			B (D)	A (C)	B (D)	
DR			B (D)	A (C)	B (D)	
AR	(DR)		A (C)	B (D)	A (C)	
AR	(GNR)		A (C)	B (D)	A (C)	
GREN	(GNR)		B (D)	A (C)	B (D)	
AAS	(DR)		B (D)	A (C)	B (D)	
R/S			A (C)	B (D)	A (C)	

NOTES:

1. Personnel designated for alternate positions must be trained for those positions.

2. Rest Periods:
   A: 2000-0200 hours
   B: 0200-0800 hours
   C: 0800-1400 hours
   D: 1400-2000 hours

3. Parenthetically referenced rest periods are alternate rest periods in the event the tactical situation dictates, or inverted scheduling is in effect.

APPENDIX B

THE EFFECTS OF SLEEP LOSS

Any discussion of human factors in night operations must of necessity include the effects of sleep loss on performance. It is very unlikely that there will be many night operations for which soldiers will have been able to rest during the preceding daylight hours.

There is a considerable body of research on the effects of sleep loss--most of it conducted under experimental conditions. Although there were a number of field studies, there seems to have been no research to determine how well findings obtained under experimental conditions predict performance in combat or in field exercises.

Studies on the effects of sleep loss have typically been concerned with performance on various military tasks performed by enlisted personnel. For example, Drucker, Cannon, and Ware (1986) studied the effects on driving and target detection, Ainsworth and Bishop (1971) the effects on the various tasks of tank crews, and Banks, Sternberg, and Farrell (1970) the effects on rifle shooting, grenade-throwing accuracy and other military tasks. Some researchers, for example, Morgan, Brown, and Alluisi (1970), studied the effects on laboratory tasks.

The research in this area is voluminous and the conditions under which data were collected in various studies are usually not comparable. Some studies seem to contradict the findings of others. Woodward and Nelson (1974) reviewed much of this literature, including studies on work/rest schedules, and attempted to derive generalizations from the various findings. Those appearing to have the highest validity, as well as relevance for the purpose of this report, were edited and are presented in the following list of summary statements.

1. Depending on the task, the effect of sleep loss on performance varies widely from almost no effect to an almost complete breakdown in performance.

2. Within broad limits, the crucial variable in predicting whether sleep loss will have an effect on performance is the factor of interest. Interesting tasks involving relatively simple motor skills appear resistant to the effects of sleep loss for periods of as much as 60 hours.

3. Performance on routine, monotonous tasks tends to show rapid and severe decrements after periods of more than 24 hours without sleep.

4. Increasing task complexity or task difficulty, without a concurrent increase in interest, will result in greater performance decrement after sleep loss.

5. Newly learned skills, or skills that are not well practiced, are more affected by sleep loss than are skills that have become automatic or "second nature".

6. Staying awake for 24 hours or more impairs the acquisition and immediate recall of newly learned material (facts of discrete nature), but has little effect on recall of such material previously learned.

7. After 24 hours or more, it takes more time to learn relatively simple concepts. There is no significant impairment in quality of concept attainment. Both speed of learning and quality of concept attainment would probably be affected if a long chain of reasoning and memory of complex decision chains were involved.

8. As sleep deprivation progresses, brief intermittent lapses in perceptual performance increase in both frequency and duration.

9. Performance on self-paced tasks generally shows little loss in accuracy, but responses tend to be slower after sleep loss.

10. High-workload situations are more affected by sleep loss than are low-workload situations; in general, as the time available for making responses increases, the task becomes less sensitive to sleep loss effects.

11. Chronic sleep loss will lead to performance impairment and mood change if the sleep loss is of sufficiently long duration and the total time period sufficiently prolonged (e.g., the chronic sleep loss represented by a reduction by 50 percent in one's normal number of hours asleep per 24-hour period for seven consecutive days or more).

12. Sleep loss consistently produces impairment of vigilance performance; the major effect is an increase in missed signals or errors of omission.

13. Communications tasks are differentially affected by sleep loss. Typically, the time required for sending information increases with sleep loss, as does the number of errors, although the errors generally are corrected. In receiving information, however, errors of omission (of missing part of the message) increase significantly with sleep loss.

14. Tasks that involve varied physical activities are usually more resistant to performance decrement during continuous work periods of 36 to 48 hours without sleep than are relatively sedentary tasks primarily requiring mental activity.

15. During a work period beginning between 0800-1200, major performance decrements first appear after approximately 18 hours of continuous work. The poorest performance frequently occurs between 0200-0600 hours, which corresponds to the low segment in the typical circadian rhythm.

16. Typically, performance impairment during continuous work tends to increase as a function of the number of hours spent awake, but is subject to

a superimposed variation from the influence of circadian rhythms.

17. Average performance decrements as great as 40 percent below baseline levels can be expected toward the end of a 48-hour period of continuous work with no sleep, breaks, or catnaps.

18. The wide individual differences in performance induced by sleep loss are not related to standard measures of personality or intelligence.

19. Breaks in a task appear to delay the occurrence of sleep-induced lapses until later stages of the work period.

20. The performance effects of sleep loss are usually accentuated as time on task increases and rest periods or breaks in routine are not permitted. Almost any interruption of the task helps to return performance to the initial level, but performance tends to decline quickly if the task is immediately returned to after the break.

21. As sleep loss increases, performance becomes more uneven, with periodic lapses in efficiency being more characteristic than a continuous depression of performance.

22. Sleep loss consistently produces an increase in average reaction time to a designated stimulus.

23. In work situations with several tasks that are differentially weighted in importance, the operator will attempt to maintain his performance on the primary or more important task at the expense of poorer performance on less-important or secondary tasks. This is especially true if the operator is at or near his performance-load capability.

24. The 12-hour period preceding a prolonged work or sleep loss period should be kept as free of duties as possible and, ideally, should be spent in sleep to minimize performance decrements during the later sleep-loss period.

25. After 36 or 48 hours of continuous work without sleep, six hours of sleep (or less) is inadequate to return performance to normal evels. Recovery generally is complete after 12 hours of sleep/rest, although subjective fatigue is reported until after the third full night of sleep.

26. Sleep loss of 72 to 96 hours will require more than one recovery night of sleep before performance recovery is complete.

27. If a period of 36 to 48 hours of continuous work is imposed on a normal load of eight hours per day, 12 hours of rest appears sufficient for normal recovery. If the same load is imposed on a work load of 12 to 16 hours a day, it may take as much as 24 hours of rest for performance to recover.

28. After enduring a stressful period of sleep loss and having gone to sleep, personnel should not be a wakeneed for duty until they have obtained adequate sleep, unless one is prepared to accept very low performance efficiency in their work.

29. Task rotation among cross-trained crew members will reduce performance deterioration, especially for relatively routine, boring tasks. Complex tasks involving decision-making will benefit least from crew rotation unless the men are well-practiced and expert in shifting functions.

30. Stimulant drugs will alleviate some of the performance-degrading effects of sleep loss.

31. Mild physical activity, such as walking around,frequently will alleviate sleep-loss effects temporarily.

32. Work-rest schedules of "2 on - 2 off," "4 on - 2 off," "4 on - 4 off," "6 on - 2 off," "6 on - 6 off," "8 on - 4 off," and "8 on - 8 off" can be maintained equally well in terms of performance decrement for periods up to five days.

33. Work-rest schedules of "4 on - 4 off" and "16 on - 8 off" can be maintained equally well in terms of performance effectiveness for periods up to two weeks.

34. Under stressful conditions,"4 on - 2 off" and "6 on - 2 off" schedules tend to result in poorer performance than do schedules which allow longer off duty periods.

35. Adaptation of biological rhythms to an atypical work-rest schedule requires, on the average, a three- to four-week time period.

36. Adaptation to a changed schedule will be enhanced to the extent that the individual synchronizes his sleep with the sleep phase of the new schedule.

37. A period of three to five days typically is required for a beginning of biological adaptation of day-shift work.

38. Readaptation to a "normal" day-night cycle, after having phase-shifted, can occur in three to five days.

39. Stable day-night shift workers generally perform more effectively than do workers who rotate day and night shifts frequently.

40. For the average worker, night-shift work performance is generally poorer than day-shift work performance. The stabilized night shift worker, however, performs as well as the day shift worker.

A three-volume report on human performance in continuous operations was published by the ARI (Siegel, Pfeiffer, Kopstein, Wilson, & Ozkaptan, 1979; Kopstein, Seigel, Wilson, & Ozkaptan, 1979; Siegel, Pfeiffer, Kopstein, Wolf, & Ozkaptan, 1980). Its aim was to provide guidelines for planning and doctrine development. With respect to the effects of sleep loss on performance, the report does not seem to add anything significant to the

review by Woodward and Nelson (1974) summarized above, presumably because little relevant research had been conducted during the five-year interval. However, the first volume (Siegel et al., 1979) provides guidelines for counteracting human performance degradation in continuous operations. Some of these are relevant for training rather than for operations or doctrine development; and some apply to military operations in general, whether continuous or not. They are organized into categories of critical abilities. An edited and abbreviated version of the list is presented below.

1. Communication

    a. Establish a feasible maximum of SOPs together with a brief code designation of each.

    b. As much as possible communicate only codes representing preestablished SOPs.

    c. Through anticipations or questions, prompt the attempts of exhausted persons to formulate a message.

    d. For maximum likelihood of comprehension in the presence of noise, establish and use the smallest feasible standard vocabulary.

    e. Also, repeat critical words and, if feasible, provide a context for better intelligibility.

    f. As much as possible, duplicate/augment critical message elements in alternate communications channels (e.g., verbal and visual).

    g. Establish standard message formats (e.g., order of message elements) for standard purposes (e.g., target descriptions, relocations directions).

2. Hearing

    a. As much as possible ensure mutual visibility of speaker and listener.

    b. When listening for faint sounds, take account of sound impeding objects in the environment (bushes, trees, etc.) and maintain a clear soundpath in expected direction.

3. Memory

    a. Extensively practice recall of standard items (SOPs, nomenclatures, codes, etc.).

    b. Retain, at all times, provisions for recording information to be retained only for a short time (e.g., note pad).

    c. Develop coding schemes which make sense to the user.

    d. Use redundancy to increase memory.

    e. A standard operating procedure of solutions may be emloyed to lessen need for memory of details.

f. As a technique to improve immediate memory the chunking or grouping of items may be employed.

4. Numerical Facility

a. As much as possible do not rely on mental arithmetic, but externalize steps (e.g., on paper) of calculational process.

b. Arrange for double check on numerical results through repetition or by others.

c. Similarly, guard against digit reversals or transpositions in numerically encoded information.

d. A much as possible reduce numerical operations to the simplest level, e.g., counting rather than adding, adding rather than multiplying, etc.

5. Perceptual Speed

a. Brief personnel in advance on expected targets and their expected patterns or distribution.

6. Reasoning

a. Develop and practice standard schemes for evaluating common types of situations or problems.

b. Prepare and use decision aids for standard types of problems (nonmographs, tables, or, when practical, computer programs)

c. Rely on parallel, but <u>independent</u> reasoning (two persons) in reaching decisions; compare results and evaluate discrepancies.

d. Provide maximum rest for decision makers 1.

7. Vigilance

a. Rotate target detection vigilance tasks among two or more people in brief (e.g., five minute) intervals.

8. General

a. Use mild exercise to increase the arousal level of fatigued, but temporarily physically inactive personnel.

b. If possible, make parallel assignments or practice task sharing.

c. Use performance supports for critical tasks.

d. Provide rest whenever possible.

Studies on sleep deprivation that use soldiers in field experiments are often suspect. Most soldiers are able to take short naps under noisy

conditions and in almost any body position. Anytime there are more soldiers in an experiment than can be watched by the experimenters, such napping is likely to occur. The authors of one study (Banks et al, 1970) actually report that this was the case in their experiment, thus unwittingly raising a question concerning the validity of their own data. The latter, not surprisingly, indicate that there was no performance degradation in rifle firing, grenade throwing and target detection with the starlight scope after 26, 28, and 40 hours of "continuous operations" respectively.

While the literature indicates that cognitive tasks are more severely affected than physical tasks, it does not especially focus on performance degradation among military leaders--commanders and their staff. Manning and Ingraham (1981) observed behavior in a field artillery battalion during an exercise that included a 36-hour continuous operations scenario. They noted that psychological rather than physiological exhaustion was the critical problem created by sleep deprivation, and concluded that commanders and battery executive officers, and those whose jobs involve primarily cogniti skills, such as batallion staff, will very likely be more susceptible to the stress of continuous high intensity combat than those with labor-intensive jobs. The authors also noted that forced-paced activities such as responding to requests for fire from forward observers and higher headquarters continued to produce timely, high-level performance, while self-paced activities, such as updating meteorological corrections and plotting potential targets and preplanned fire and no-fire zones, became degraded.

On the basis of his observations during the REFORGER 78 exercise, Manning (1979) concluded that the high sensitivity of decision making and other cognitive tasks to fatigue makes it imperative that commanders get some sleep during continuous operations. But the very helpful taking of brief naps was constantly undermined by the common myth that sleeping is unmanly or a manifestation of poor discipline--a myth he found most prevalent among commanders themselves.

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